CONCRETE LABORATORIES FACT SHEET

Research that is Essential, Indispensable, and Connected to our Customers.

PURPOSE

The Concrete Laboratories provide support in the following areas: Investigating the properties and performance of portland cement concrete (PCC) and its component materials (cement, aggregate, admixtures, etc.); evaluating and developing new or improved equipment and procedures for assessing properties and performance of PCC, and practices for materials selection, mixture proportioning, and construction of PCC; mixing, casting, and testing of PCC test specimens in support of other researchers at the Turner-Fairbank Highway Research Center (TFHRC); specialized testing and forensic investigations on PCC to assist State DOTs in research and troubleshooting problems with existing pavements and structures.

DESCRIPTION

The Concrete Laboratories consist of several laboratories that are equipped with standard laboratory equipment (ovens, scales, etc.), as well as specialized equipment for concrete testing. The laboratories function as a unit to provide facilities for research on PCC and its constituent materials.

- The ***Aggregate and Sample Preparation Laboratory*** provides facilities for the preparation of aggregate samples for concrete and the preparation of hardened cement paste, mortar, or concrete specimens for testing and analysis. Equipment includes two rock crushers, a pulverizer, a vibrating screen, a Gilson TestMaster, standard sieves, a Videograder (for automated sizing and shape analysis of aggregate), two water-cooled saws, lapping wheels, a lathe for profile grinding, and a muffle furnace.
- The ***Concrete Curing/Maturity Laboratory*** provides facilities for curing of concrete specimens under standard or other controlled conditions and assessment of curing-related properties, such as degree of hydration, maturity, and shrinkage. Equipment includes three heated curing tanks, two walk-in environmental chambers (2.4-m [8 ft by 8 ft]), and a 189.3-l (50-gallon) water bath.
- The ***Concrete Durability Laboratory*** provides facilities for investigating the effects of chemical and environmental exposure on concrete. The laboratory is equipped to assess alkali-aggregate reaction; sulfate attack; chloride penetration; freezing, thawing, and thermal effects. Equipment includes an automated freeze-thaw, chamber with the capacity for 60 specimens, thermal coefficient test frames (developed in-house) and bath, and computer-controlled chloride penetration test equipment.
- The ***Mechanical Properties Laboratory*** provides facilities for testing the mechanical properties of concrete, steel, and composites. Equipment includes three servo-controlled universal testing machines with capacities ranging from 267 kN to 1,780 kN (60,000 lbs. to 400,000 lbs.), a 4,448 kN (1,000,000-lb.) compression testing machine, a compressometer/extensometer, and four creep frames.
- The ***Plastic Concrete Laboratory*** provides facilities for batching and mixing cement paste, mortar, and concrete; and for performing tests on fresh (plastic) cement paste, mortar, and concrete. Two drum mixers and a two-cubic-foot pan mixer are available for mixing.
- The ***Petrographic Laboratory*** provides facilities for preparing for and conducting petrographic and microscopic investigations of aggregate, PCC, and asphalt concrete. Equipment includes several types of microscopes (including an epi-fluorescent polarizing microscope), a semi-automated air void analysis system, image analysis hardware/software, and thin-section preparation equipment.

LAB VALUE

TFHRC's Concrete Laboratories provide an FHWA-wide resource for concrete related specialized testing, evaluation of new test methods, concrete materials research, and concrete forensics. Since the Concrete laboratories are on site at TFHRC, lab personnel have access to many disciplines of engineering to provide innovative solutions to challenges faced by the FHWA community.

In more detail, the labs provide the following services:

- ***Concrete related specialized testing:*** The investment made in equipment and training in the Concrete Laboratories gives the lab the ability to evaluate properties of concrete from materials selection, mixture design, plastic properties related to place-

The Turner-Fairbank Highway Research Center (TFHRC) has more than 24 laboratories for research in the following areas: safety operations, including intelligent transportation systems; materials technology; pavements; structures; and human centered systems. The expertise of TFHRC scientists and engineers covers more than 20 transportation-related disciplines, these laboratories are a vital resource for advancing this body of knowledge created and nurtured by our researchers. The Federal Highway Administration's Research, Development, and Technology Service Business Unit operates and manages TFHRC to conduct innovative research to provide solutions to transportation problems both nationwide and internationally. TFHRC is located in McLean, Virginia. Information on TFHRC is available on the Web at ***www.tfhrc.gov****.*

ment, and long term durability. The holistic approach from materials to long-term durability becomes more important as the demands for a more durable, longer service life concrete has become the standard.

- ***Evaluation of new test methods:*** With equipment available on site and the resources of an on site Electronic Laboratory and Machine Shop, the Concrete Laboratories have the ability to evaluate and develop new test methods. Recognizing a need in the design community, the labs developed the Coefficient of Thermal Expansion of Concrete test method that is now an American Association of State Highway and Transportation Officials (AASHTO) Provisional Specification. The labs also act as an evaluator of proposed test methods, making recommendations for test suitability and forwarding results to the Mobile Concrete Laboratory (operated by the Office of Pavement Technology) and to other appropriate teams.
- ***Concrete materials research:*** The labs have the capabilities to perform concrete materials research ranging from the micro scale to the macro scale, from materials characterization to materials distress mitigation.
- ***Concrete forensics:*** When problems do occur and a decision must be made to determine the most life-cycle cost-effective repair to the structure or pavement, understanding the cause of the failure is an important decision-making tool. The Concrete Laboratories have the capabilities needed to provide this service in conjunction with other laboratories on site to find the cause of the failure and to provide input on how to mitigate the problem.

PRODUCTS AND SERVICES

- An AASHTO provisional standard test method for measurement of the coefficient of thermal expansion (CTE) of concrete.
- An interactive Web-based program for optimizing concrete mixtures using statistical methods.
- Papers presented/published on thermal coefficient testing, alkali silica reaction (ASR) testing, freeze-thaw durability, mixture optimization.
- Assistance provided to Delaware, the District of Columbia, Missouri, Texas, Pennsylvania, and Puerto Rico in research or in troubleshooting concrete problems.

LAB PARTNERS

The Concrete Laboratories have been, and are currently, involved in cooperative efforts with various partners. The laboratories also provide assistance to customers such as State DOTs and other Federal Highway Administration (FHWA) researchers.

- Cooperative research with the National Institute of Standard and Technology (NIST) on concrete mixture optimization and curing.
- Assistance to Missouri DOT on a project involving image analysis of air voids in concrete.
- Troubleshooting/forensic investigations of concrete problems for Delaware, the District of Columbia, and Puerto Rico.
- Participation in the field evaluation of a new test method for an FHWA contract project on chloride penetration.
- Materials testing for the Accelerated Load Facility (ALF)/Ultra-Thin Whitetopping (UTW) project (sponsored by industry).
- Support for other FHWA research efforts at TFHRC involving concrete, such as research projects on DEF and chloride assessment.

CURRENT PROJECTS

- Investigation of ASR test methods for concrete mixtures.
- Investigation of the durability of concrete with marginal air contents and improved methods for characterizing damage in freeze-thaw tests.
- Evaluation of the US Army Corps of Engineers (USACE) workability device.
- Ongoing assistance to States and other researchers at TFHRC.
- CTE testing in support of the Long Term Pavement Performance Program (LTPP).

EXPERTISE

The labs combine the expertise of the FHWA laboratory manager, a materials engineer with wide ranging training and experience in the areas of concrete making materials, concrete behavior and concrete testing. Particular expertise is possessed in the analysis of air void systems in concrete as they relate to concrete freeze-thaw durability; the Concrete Lab manager, a Materials engineer with 18 years of civil engineering materials experience in a research and development environment with focus on the durability of High Performance Concrete for pavements and structures with specific interests in cracking and shrinkage performance; the staff petrographer, a PhD in Civil Engineering with 2 years experience as a petrographer and several additional years of experience in cement chemistry and admixture development; and three concrete technicians with basic concrete testing skills. Technician training includes American Concrete Institute (ACI) certification and attending the National Ready Mixed Concrete Association (NRMCA) Short Course on concrete and aggregates. Additional experience includes cement chemistry, geology, concrete corrosion, and nondestructive test techniques.

STATISTICS

The Concrete Laboratories developed the Coefficient of Thermal Expansion of Concrete test method that is now an AASHTO Provisional Standard. This property is important to the performance of concrete in all types of structures, including pavements and bridges. The *2002 AASHTO Pavement Design Guide*, currently under development, will utilize results from this test as one of the inputs in order to determine the proper pavement design.